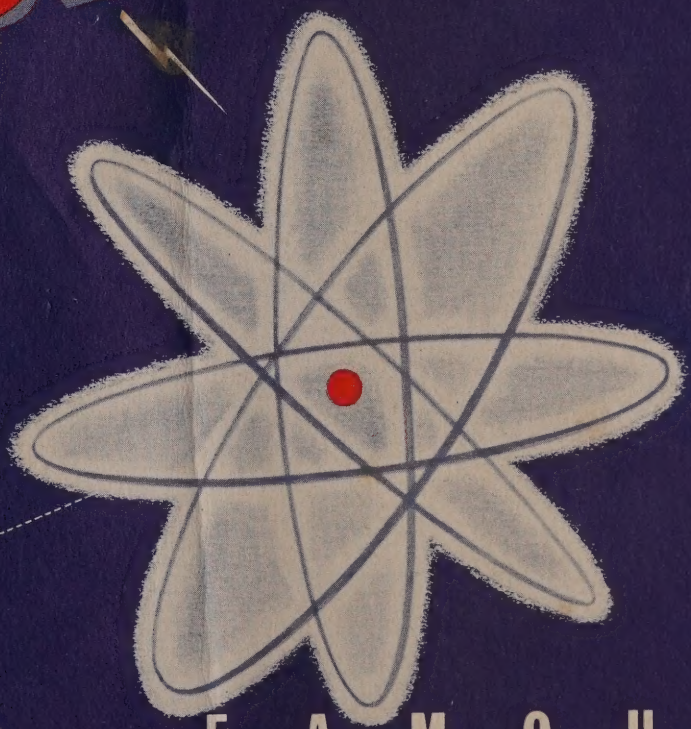
OPERATING INSTRUCTIONS

CATHODE RAY OSCILLOSCOPE
MODEL 670

HICKOK



WORLD FAMOUS

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 DUPONT AVENUE • CLEVELAND 8, OHIO
The Standard of Quality for Over 40 Years

OPERATING INSTRUCTIONS

FOR

CATHODE RAY OSCILLOSCOPE
MODEL 670

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 DUPONT AVENUE
CLEVELAND 8, OHIO

IB-670-1051

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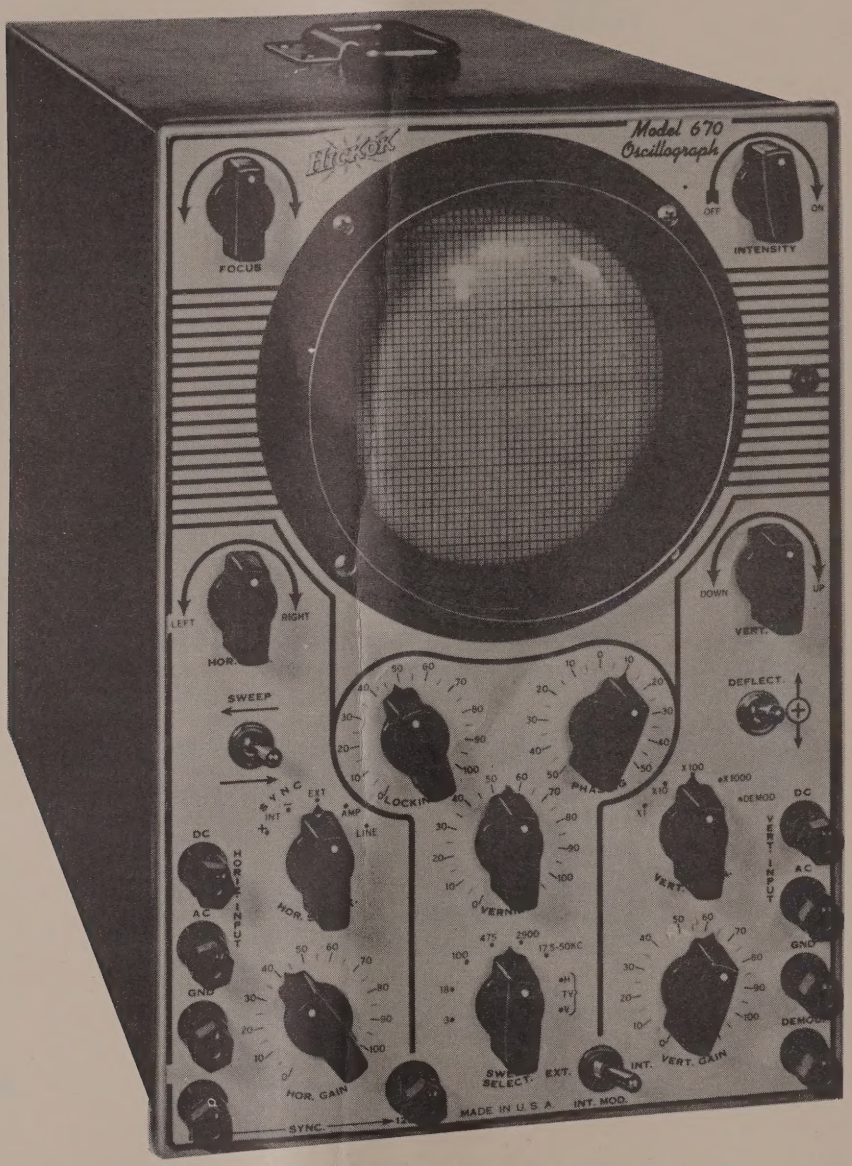

FIGURE 1.1 - CATHODE RAY OSCILLOSCOPE MODEL 670

TECHNICAL DATA SHEET

EQUIPMENT SUPPLIED

(ONE COMPLETE UNIT)

Quan.	Name	Style	Stock No.	Dimensions	Weight
1	Cathode Ray Oscilloscope	670	902-195	13¼ x 9¼ x 19"	13 Lbs.
1	Instruction Book		2490-165	8½ x 11"	
1	Test Lead - Gnd.		12450-225	48"	
1	Test Lead - Shielded		3030-58	48"	

TECHNICAL CHARACTERISTICS

1. POWER SUPPLY REQUIRED: 105-125 volts, 50-70 cycles, AC

2. POWER CONSUMPTION: 65 watts at 115 volts

3. DEFLECTION SENSITIVITY:

   a. Vertical Amplifier: .01 volt (RMS)/inch
   b. Vertical Direct: 12 volts (RMS)/inch
   c. Horizontal Amplifier: .07 volt (RMS)/inch
   d. Horizontal Direct: 13 volts (RMS)/inch

4. INPUT IMPEDANCE:

   a. Vertical Amplifier: 2.2 megohms, 30 mmf.
   b. Vertical Direct: 3.3 megohms
   c. Horizontal Amplifier: 1 megohm, 35 mmf.
   d. Horizontal Direct: 3.3 megohms

5. FREQUENCY RANGE:

   a. Vertical Amplifier: Useful beyond 1 mc; pulse rise time 0.6 microsecond
   b. Horizontal Amplifier: 0 to 100 kc; pulse rise time 3.8 microseconds

6. TUBE COMPLEMENT:

Tube	Stock No.	Function
V1 - 12AU7	20875-69	Cathode Follower-Vertical Amplifier
V2 - 12AT7	20875-77	1st Vertical Amplifier
V3 - 6J6	20875-71	2nd Vertical Amplifier
V4 - 6J6	20875-71	3rd Vertical Amplifier
V5 - 6J6	20875-71	Sweep Circuit Oscillator
V6 - 6C4	20875-62	Blanking Amplifier
V7 - 5UP1	20875-67	Cathode Ray Tube
V8 - 6AX5	20875-88	Low Voltage Rectifier
V9 - 1V2	20875-86	High Voltage Rectifier
V10 - 6C4	20875-62	1st Horizontal Amplifier
V11 - 6J6	20875-71	2nd Horizontal Amplifier

STANDARD RTMA GUARANTEE

The Hickok Electrical Instrument Company warrants instruments manufactured by it to be free from defective material or factory workmanship and agrees to repair such instruments which under normal use and service, discloses the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any instrument or test equipment which proves to be defective, when returned to us, transportation prepaid, within ninety (90) days from the date of original purchase and provided the serial number has been made known to us promptly for our records.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons or service stations in any way so as, in our judgment, to injure their stability or reliability or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced, or removed. Neither does this warranty apply to any of our products which have been connected, installed, or adjusted otherwise than in accordance with the instructions furnished by us. Accessories including all vacuum tubes not of our manufacture used in this product are not covered by this warranty.

This warranty is in lieu of all other warranties expressed or implied and no representatives or person is authorized to assume for us any other liability in connection with the sale of our products.

Parts will be made available for a minimum period of five (5) years after the manufacture of this equipment has been discontinued. Parts include all materials, charts, instructions, diagrams, accessories, etc, which have been furnished in the standard model.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Address all service inquiries to The Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio

REGISTRATION CARD

The above RTMA guarantee is contingent upon the attached registration card being returned to the factory immediately upon receipt of the equipment.

SECTION 1 - DESCRIPTION

1.1 PURPOSE

a. The Model 670 oscilloscope is a general purpose instrument which permits a complete visual analysis of electrical and electronic circuits. The effectiveness of a tube or circuit as an amplifier, rectifier or source of special wave shapes may be readily determined. Using Lissajou's figures, the oscilloscope provides a quick and easy method of determining unknown frequencies.

b. The Model 670 provides an accurate and versatile means of visually studying and interpreting electrical phenomena such as modulation, phase relations, voltage amplitude, distortion, etc. Because of the design of the cathode ray tube and its associated circuit, the Model 670 will respond accurately to voltages in wide ranges of both frequencies and amplitudes. Permanent records may be made of any pattern, or series of patterns, by photography.

c. When used in conjunction with a source of frequency modulated radio frequency energy, such as is obtained from the Hickok Model 610A or 288X signal generators, this scope provides a means of visual alignment of television, amplitude and frequency modulated receivers.

1.2 DESCRIPTION

a. Physical--The Model 670, shown in Figure 1.1, is a portable oscilloscope. The front panel is of satin chrome finish with all switches, controls and connectors clearly marked. This panel is divided functionally into five main controls: focus and intensity, horizontal deflection, vertical deflection, weep circuit oscillator, and external connections. The instrument case is of steel with blue baked lacquer finish and is furnished with a carrying handle and four blister feet.

b. Electrical--The basic circuits of the Model 670 are illustrated in block form in Figure 1.2. These circuits are explained more fully in Section 2, Theory.

c. Functional--The Model 670 oscilloscope will perform the following functions:

(1) Provide a means of visually studying and interpreting electric and magnetic phenomena.

(2) Permit the study and analysis of wave forms.

(3) Provide a means of measuring voltages and frequencies of AC signals.

(4) Permit visual testing and alignment of amplitude and frequency modulated receivers, and television equipment when used in conjunction with a frequency modulated RF oscillator such as the Hickok 610A or 288X signal generators.

(5) Permit measurement of hum, gain and distortion in audio amplifiers.

d. Components--The AC power line cord is permanently attached. Two test leads are furnished separately. One of these is a 48-inch unshielded, black test lead with an alligator clip on one end and a spade clip on the other. The second is a 48-inch shielded cable with an alligator clip on one end and two spade clips on the other.

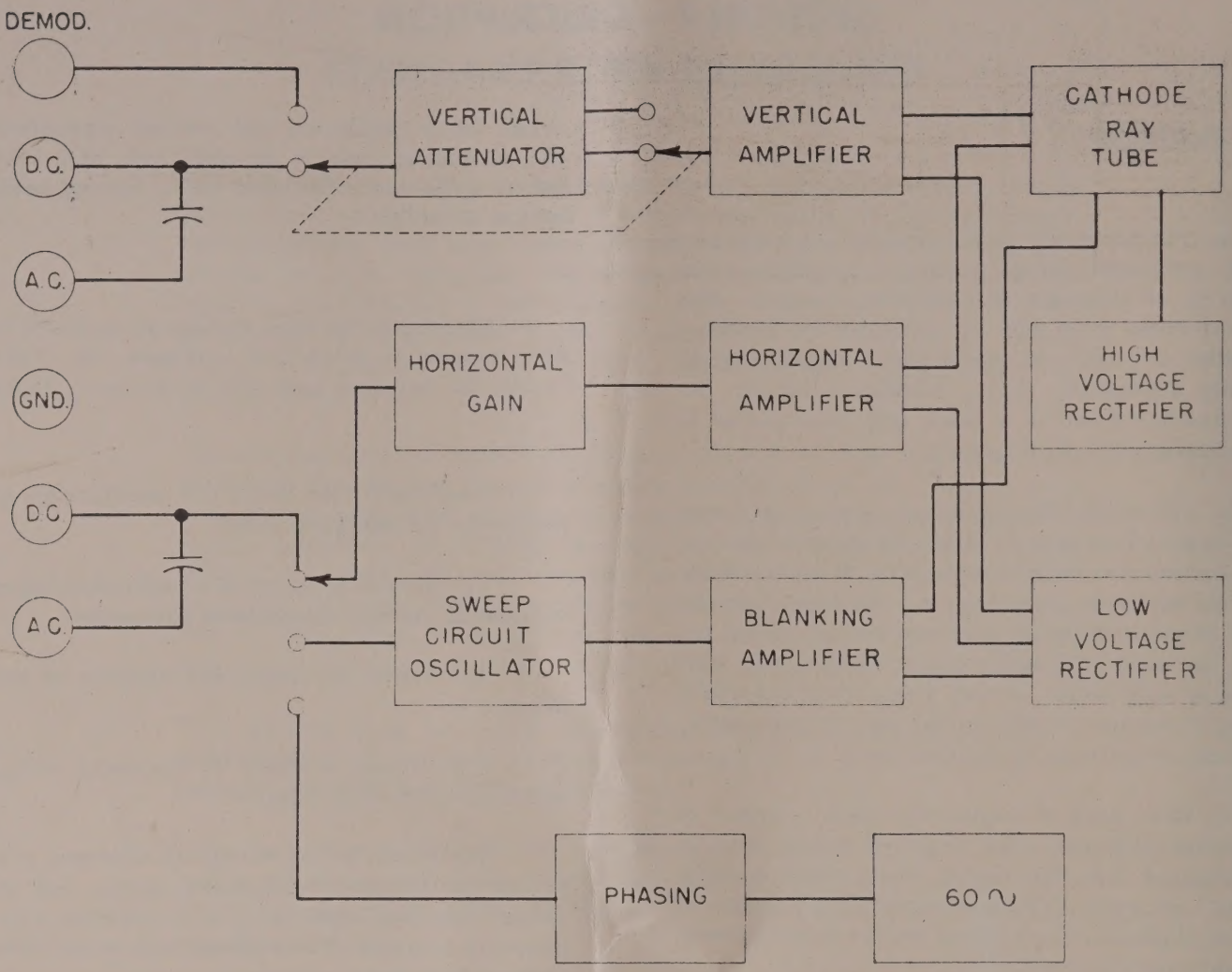

FIGURE 1.2 - BASIC CIRCUITS, IN BLOCK FORM

SECTION 2 - THEORY

2.1 GENERAL

It is essential for proper operation of the Model 670 and correct interpretation of the oscilloscope patterns obtained that the operation of the oscilloscope, particularly the cathode ray tube, be thoroughly understood. The interpretation of patterns obtainable has been left to the Technical Bulletin 342, copy of which is furnished with the instrument.

2.2 CATHODE RAY TUBE

a. The cathode ray tube, shown in Figure 2.1, may be considered as having three basic parts: the electron gun, producing the electron beam; the deflecting plates, controlling the direction of the electron beam; and the fluorescent screen for viewing the beam.

(1) Electron Gun--Tne cathode, A, when heated, emits a stream of electrons which is controlled as to intensity by the grid, B. Anode #1, C, and anode #2, D, accelerate and control the focus of the electrons. With no further controls, a stream of electrons will be produced, focused and accelerated so as to form a beam striking the end of the cathode ray tube in a small, clearly defined spot.

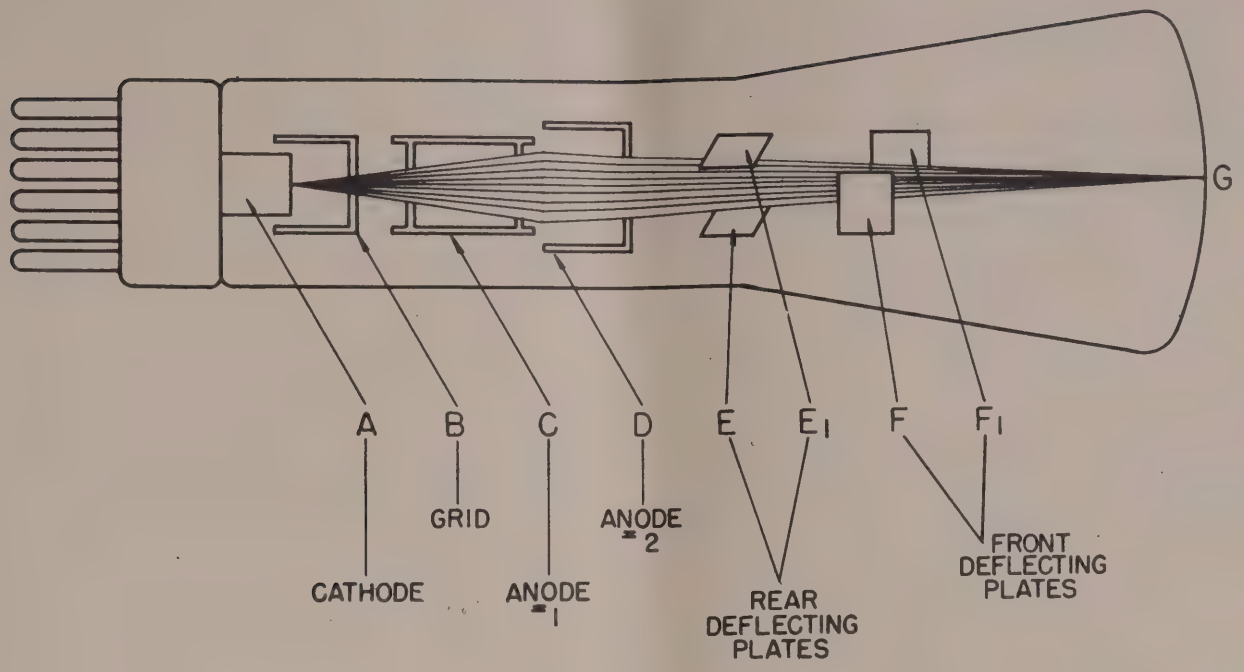

FIGURE 2.1 - CATHODE RAY TUBE

(2) Deflecting Plates--The beam of electrons, being negatively charged, will be attracted and repelled by positive and negative charges respectively. Thus, if a set of plates, between which the beam is to travel, is added to the cathode ray tube in a vertical position and an AC voltage is applied to it, the beam will be alternately attracted and repelled by each plate in such a manner as to cause the electron beam to travel or sweep horizontally. Similarly, AC voltages applied to a set of plates in the horizontal position will cause the beam to sweep vertically. AC voltages placed on both sets of plates simultaneously will cause the beam to describe a pattern which is the resultant of the two voltages.

(3) Screen--The end of the cathode ray tube upon which the beam of electrons impinges has been chemically treated so that the screen will fluoresce when the electrons impinge upon it, making a visual pattern possible.

b. Cathode Ray Tube Circuit--The cathode ray tube and its associated electronic circuits used in the Model 670 are shown in the schematic wiring diagram, Figure 5.1. There are four main controls of the cathode ray tube:

(1) Intensity--potentiometer control (R66) of of the voltage on the control grid which varies the intensity of the electron beam.

(2) Focus--potentiometer control (R70) of the voltage on anode #1 which accelerates and focuses the electrons of the beam.

(3) Vertical Positioning--potentiometer control (R1) of the voltage on the horizontal deflecting plates which control the vertical position of the beam.

(4) Horizontal Positioning--potentiometer control (R80) of the voltage on the vertical deflecting plates which control the horizontal position of the beam.

2.3 VERTICAL AMPLIFIER

The vertical amplifier consists of four tubes: V1 (12AU7), a cathode follower; V2 (12AT7), 1st vertical amplifier; V3 (6J6), 2nd vertical amplifier; V4 (6J6) 3rd vertical amplifier. Complex voltages can be applied to the vertical deflection plates directly or through a high gain stable amplifier.

Voltages, either AC or DC, applied to their respective input and ground posts may be attenuated by the RC compensated pad. This pad consists of four positions: X1, X10, X100 and X1000. At any selection of these four positions the network is frequency com-

pensated so that no overshoot is present when the input voltage is a square pulse. The voltage is fed to the grid of the cathode follower V1, pin 2. Pin 7 is grounded, making this other triode section a grounded grid amplifier. A balance potentiometer R28 is in one leg of the cathode of this triode section. It is adjusted so that the DC potential between pins 3 and 8 is zero. Vertical gain control R29 is tied between these cathodes. The center arm of the gain control and pin 8 which is the cathode of the follower, are directly coupled to the first vertical amplifier grids, pins 2 and 7 respectively, through a reversing switch. Normally, this reversing switch is set so that a positive voltage will deflect the beam upward. When utilizing this amplifier in adjusting the response curves of television circuitry, the pattern may be in the negative direction; by reversing the switch, the pattern will be right side up. Signals applied to the grids of the first vertical amplifier V2 are amplified by the type 12AT7 tube. This amplified voltage appears at the plate of V2 and is directly connected to the grids of the second vertical amplifier V3 through two 47 ohm resistors. The vertical positioning control is located in the plate circuit of V2. Moving this control adjusts the bias of V3, a type 6J6. When the voltage between pins 1 and 6 is zero, the electron beam remains in the center of the screen. Calibration control R40 adjusts the plate potential which in turn, controls the bias of V3. Two 1000 ohm resistors, R38 and R39, are in the cathode legs of V2. This provides high degeneration to the amplifier for stabilizing purposes. A 220 mmf condenser, C8, is used for high frequency peaking. Calibration control R33 is adjusted so that the electron beam remains in the center of the screen. Voltages appearing on the grids, pins 5 and 6 of V3, are amplified by the 6J6. The amplified voltage taken from the plates of V3 is directly connected to pins 5 and 6 of V4 through two 47 ohm resistors. This voltage is amplified by V4, a type 6J6.

The plates of V4 are directly connected to the cathode ray deflection plates, pins 6 and 7 of V7. Calibration control R30 is adjusted so that proper bias appears between grids and cathode of V4. This potentiometer is properly adjusted for minimum distortion on the cathode ray screen. The frequency response is from zero to 500,000 cycles with 30% loss at the high end. Pulse rise time is 0.6 microsecond. The deflection sensitivity of the vertical amplifier is 10 millivolts per inch deflection.

The demodulator consisting of a 1N34 crystal can be applied to the cathode follower by rotating the vertical amplifier switch to the demodulator position.

2.4 HORIZONTAL AMPLIFIER

The horizontal amplifier is capable of amplifying the internal sawtooth of the sweep circuit oscillator, phased line frequency, or external AC or DC voltages applied to the horizontal and ground post when the horizontal selector switch is rotated to any one of these positions.

With the horizontal selector switch rotated to the amplifier position either AC or DC external voltages may be applied to the horizontal amplifier. Horizontal gain control R52 is inserted between the horizontal input and ground through switch S 3. The center arm of this control is fed to the first horizontal amplifier grid, pin 6 of V10. The amplified voltage appears at the plate of V10, and type 6C4, and is coupled directly to the second horizontal amplifier grid, pin 5. Part of this voltage appears at the cathode and is used to excite grid 2, pin 6, which is connected as a grounded grid amplifier through resistors R80 and R81. Push-pull deflection is thus obtained by this method.

The horizontal positioning control adjusts the bias of the second horizontal amplifier V11, type 6J6. Adjusting the horizontal positioning potentiometer to approximately 50% mechanical rotation adjusts the bias of the two grids, pins 5 and 6, to the same potential. The beam stays in the center of the screen because the plate potentials of V11 are equal. The amplified voltage appearing at plates 1 and 2 is coupled directly to the deflection plate pins 9 and 10 of V7 through a reversing switch, S6. The frequency range of the horizontal amplifier is zero to 100,000 cycles. Pulse rise time is 3.8 microseconds.

2.5 SWEEP CIRCUIT OSCILLATOR

A cathode coupled multivibrator utilizing a type 6J6, V5, is used as the horizontal sawtooth oscillator and operates from 3 to 50,000 cycles per second. This range of frequencies is controlled by:

a. Sweep Selector Switch, S4--Condensors C23, C26, C27, C29, C30, C31 and C32 are switched in by S4 and act alternately and respectively as sawtooth generating condensers for the second triode section, and as coupling condensers from the first triode section to the second section of the multivibrator. In the positions shown in the schematic wiring diagram, Figure 5.1, C26 is used as the sawtooth

capacitor, while C27 is used as the coupling capacitor. Two additional positions, 30 cycles and 7875 cycles fixed frequencies, are provided for observing sync and blanking wave forms in the horizontal and vertical circuits of television receivers.

b. Vernier Potentiometer, R44 and R59--Fine frequency control is accomplished by means of the vernier control in the plate and grid circuits of the second triode section of the multivibrator. Both potentiometers R44 and R59 of the vernier control are on the same shaft and adjusted by this control on the front panel.

For the two fixed frequencies of 30 cycles and 7875 cycles, R45 and R46 fixed resistance values in addition to the two calibration potentiometers R60 and R61, are used.

c. Horizontal Selector--This switch, S3, selects the synchronizing voltages, either positive or negative, for the sweep circuit oscillator. All synchronizing voltages are fed through the Locking control R53 which regulates the synchronizing amplitude to the 6J6 sawtooth oscillator tube. In the SYNC INT. + position the output voltage is picked up from the first section of the final vertical amplifiers through a 2.2 megohm resistor in shunt with 5 mmf and fed to the Locking control R53. In the SYNC INT. - position the output voltage is picked up from the second section of the final vertical amplifier through a 2.2 megohm resistor in shunt with 5 mmf and fed to the Locking control R53. In the EXT position the synchronizing voltage may be obtained from the external source connected to Ext. Sync. located on the front panel. In the AMP position the input to the horizontal amplifier is connected to the horizontal input binding post and external voltages may be applied for amplification and application to the horizontal deflection plates. The LINE position disables the sweep circuit oscillator and connects part of the line frequency to the horizontal amplifier. This line frequency works in conjunction with the PHASING control R54 and associated components C22, C24, R51 and R58. This network shifts the phase of the line voltage that is fed to the horizontal amplifier when line frequency is being used as a source of horizontal sweep.

2.6 BLANKING AMPLIFIER

The blanking amplifier V6, a type 6C4, is coupled to the cathode ray tube cathode through a .008 mfd condenser. When the sawtooth generator is operating in any of its three positions, namely, positive, negative or external sync., the return trace of the sawtooth voltage is coupled to the grid of the blanking amplifier through C16. The amplified voltage at the plate blanks out the beam of the cathode ray tube.

2.7 INTENSITY MODULATION

External voltages can be applied directly to the cathode ray grid, pin 2, through C28 when switch S5 is opened. External modulation connections are located on the rear board and are clearly marked. When S5 is closed (this is identified on the panel as "internal") the line frequency is connected to the cathode ray tube grid. When the waveform is in the positive direction, the beam lights up or intensifies. Going in the negative direction, the beam blanks out. This is used for response curves of television and radar receivers in synchronization with the LINE frequency. Two traces will appear, forward and reverse. By shorting the switch S5, one trace will be observed on the cathode ray screen.

SECTION 3 - OPERATION

3.1 GENERAL

This section will serve to explain the functioning of all controls and connectors on the front panel of the Model 670 oscilloscope.

If unfamiliar with the basic theory of the cathode ray tube itself, it would be advisable to re-read the theory of operation of the cathode ray tube in order to better understand the functioning of those controls pertaining to the proper adjustment of the tube before any external source of voltage is connected to the unit. This explanation is given in Section 2, Theory.

3.2 CONTROLS AND THEIR FUNCTIONS

a. Cathode Ray Tube Controls

(1) POSITIONING, DOWN-UP: a potentiometer control of the vertical position of the cathode ray pattern.

(2) POSITIONING, LEFT-RIGHT: a potentiometer control of the horizontal position of the cathode ray pattern.

(3) INTENSITY: the extreme counter-clockwise position of this control functions as the POWER

ON-OFF switch. After the power is turned on, it acts as a control of the intensity of the beam by controlling the voltage.

(4) FOCUS: a potentiometer control of the cathode ray beam to produce a finely defined pattern.

b. Vertical Controls

(1) SELECTOR: a control of the vertical input voltages to the cathode ray tube. There are five positions available: AMP. ATTENUATION 1, 10, 100 and 1000, and DEMOD. In the AMP. ATTENUATION positions, the selected relative percentage of signal voltage being observed is applied to the input of the vertical amplifier circuits. In the DEMOD. position, the modulated RF input is fed to the demodulator where the signal is detected. The demodulated signal is then fed through the vertical amplifier to the vertical plates of the cathode ray tube.

(2) GAIN: a potentiometer control of the voltages applied to the vertical amplifier input.

(3) INPUT-GND (AC or DC): binding post connections for an external source of vertical amplifier input.

(4) DIRECT CONNECTION TO VERTICAL PLATES: In the rear of the case in an access to four terminals connected together by jumpers. By removing the two jumpers labeled D1 - Vertical Amplifier, and D2 - Vertical Amplifier, voltage may be fed to the two deflecting plates.

(5) REVERSING SWITCH: a switch control for reversing the polarity of the electron beam in the vertical plane.

c. Horizontal Controls

(1) HORIZ. SELECT.: a control of the horizontal sweep of the electron beam. There are five positions available: positive, negative or external sync.; horizontal amplifier, and line frequency. In the positive and negative sync. positions, the horizontal sweep is obtained from the internal sweep circuit oscillator and may be of any frequency from 3 cycles to 50 kc. The output of the sweep circuit oscillator is of a sawtooth wave form. With such a sweep, the beam progresses from the left to the right at a constant rate and returns to the left almost instantaneously to start the next sweep. This effectively plots time along the horizontal axis.

In the external sync. position the sweep circuit oscillator may be synchronized from an external source of voltage applied at the external sync. binding post. If a jumper is connected between the 120 cycle binding post and external sync. binding post the sweep circuit oscillator will be synchronized from an internal source of 120 cycle or two times line frequency.

In the horizontal amplifier position, AC or DC voltages connected to the horizontal input binding posts are connected through the horizontal amplifier to the horizontal deflecting plates. In the line frequency position, the horizontal sweep is of the wave form and frequency of the AC power supply (usually a 60 cycle sine wave).

(2) GAIN: a potentiometer control of the input voltages applied to the horizontal amplifier and, subsequently, to the horizontal deflecting plates of the cathode ray tube.

(3) HORIZ. INPUT-GND: bindi.,; post connection, AC or DC external voltage for horizontal deflection.

(4) PHASING: this control is only effective when the horizontal selector switch is in the Line position. It is used to superimpose the forward and return traces when the Model 670 is used for visual alignment of AM and FM receivers.

(5) REVERSING SWITCH: a switch control for reversing the polarity of the electron beam in the horizontal plane.

d. Sweep Circuit Controls

(1) STEPS: a control comprising 8 ranges, 6 of which provide coarse adjustment of the frequency of the sawtooth sweep oscillator from 3 cycles to 50 kc. The remaining two ranges are fixed frequencies for horizontal and vertical sync. pulses of TV receivers, being 7875 and 30 cycles respectively.

(2) VERNIER: A variable control of the frequency of the sawtooth sweep oscillator within the range covered by any one of the 6 positions of the STEPS control. The other two positions have calibration potentiometers to fix the frequency of the two remaining positions of the STEPS control.

(3) INTENSITY MODULATION: a two-position toggle switch permitting intensity (Z axis) modulation of the cathode ray tube from either an external source, when turned to this position, or from an internal 60 cycle source, when turned to this position, in which case the return trace is blanked out. Internal intensity modulation should never be used except when the

horizontal selector is in the "Line" position. Connections for external intensity modulation are made to a connector located on the terminal board accessible through a door in the rear of the case and labeled INT. MOD.

(4) LOCKING: a variable control permitting the adjustment of the amplitude of the locking voltage used to synchronize the sweep circuit oscillator.

3.3 CAUTIONS

a. Never turn on the oscilloscope with the case removed as very high voltages are present.

b. Do not have a spot or trace in one place for a long period of time as it may burn that part of the screen. When the trace is not being observed, the intensity control should be adjusted until the spot disappears.

3.4 PRECAUTIONS

a. Be sure that the power supply line is 105-125 volts, 50-70 cycles, AC.

b. Be sure that the beam has been properly centered before trying to interpret patterns.

c. Set the focus and intensity controls for the smallest spot with the minimum readable brilliancy in order to preserve the life of the tube.

d. To prevent distortion, use as little locking voltage as possible to cause the image to remain stationary.

3.5 PRELIMINARY OPERATION

a. Rotate the intensity control from off. An audible click should be heard and the pilot lamp should light. Allow time for the cathodes to heat sufficiently for stable operation.

b. Adjust the intensity control until the minimum desired brilliance is obtained.

c. Adjust the focus control until the beam becomes a point or fine line.

d. Adjust the horizontal positioning of the spot by rotating this control to the left or right as required.

e. Adjust the vertical positioning of the spot by rotating this control in the up or down direction as required.

f. Horizontal and vertical gain controls should be advanced to give suitable deflection. These settings will vary with the application for which the scope is to be used.

g. Further settings of the controls of the Model 670 will depend upon the application made.

SECTION 4 - MAINTENANCE

4.1 GENERAL

As the Model 670 has been built under the high standards of workmanship and quality of material of a Hickok instrument, no maintenance other than routine replacement of tubes should be necessary. It is suggested that, should the instrument need maintenance other than routine replacements, the factory be contacted in accordance with "Returning Equipment for Repair", page iv. The schematic wiring diagram, Figure 5.1, is included to aid in maintenance work.

CAUTION

Care should be taken when working with the Model 670 with the case removed from the chassis as there are high voltages present.

4.2 FUSE

The power supply is protected by a one ampere Slo-Blo fuse. This fuse should be checked if the pilot light does not light when the power is turned on. The fuse is readily accessible at the rear of the case and may be replaced without removing the chassis from the case.

4.3 VACUUM TUBES

All vacuum tubes are operated at, or below, their normal ratings to insure long life and uniform service. The location of the tubes is shown in Figure 4.1. All

tubes are easily accessible after the chassis has been removed from the case. To remove the chassis from the case, remove the two screws at the back of the case and pull the case away from the chassis.

4.4 CATHODE RAY TUBE

a. The cathode ray tube, type 5UP1, requires care in use and handling. There are three common causes of cathode ray tube failure:

(1) mechanical breakage of the glass envelope or internal parts, generally due to rough handling;

(2) burning of the screen; and

(3) loss of emission of the cathode.

Care should always be taken that the beam is not left in one spot for long periods of time as the screen may thus become burned or streaked. Adjust the beam for minimum readable brilliancy and smallest spot to to increase tube life.

b. To replace the cathode ray tube, the following procedure should be used:

(1) Remove the socket from the cathode ray tube.

(2) Loosen the clamp around the neck of the tube and remove the two screws holding the clamp.

(3) Remove the two screws holding the mu-metal shield at the neck of the tube.

(4) Remove the four screws and nuts at the front of the cathode ray tube.

(5) Lift tube and shield from tube support.

(6) Remove tube from mu-metal shield and front end tube support.

(7) Insert new tube in shield and place front end tube support inside shield.

(8) Insert the neck of the cathode ray tube in the rear support.

(9) Replace screws and nuts, fasten clamp and reconnect socket.

4.5 VACUUM TUBE REPLACEMENT

Should it be necessary to replace any vacuum tubes in the vertical amplifier (V1 through V4), the following procedure should be used in adjusting calibration controls R28, R40, R3, R33 and R30. With reference to Figure 4.1, it will be noted that all these controls with the exception of R3, the vertical positioning control, are located on the right side of the chassis.

PROCEDURE:

(1) Rotate the vertical gain control to approximately 50% mechanical rotation.

(2) Rotate vertical attenuator to X1000 position.

(3) Connect a DC voltmeter to pins 3 and 8 of V1, the cathode follower.

(4) Adjust the Balance control R28 so that the voltmeter reads zero.

(5) Disconnect the voltmeter and adjust R33 until the beam is in the center of the screen.

(6) Connect a jumper from the 120 cycle binding post to the vertical amplifier AC input.

(7) Adjust the attenuator and gain controls until approximately one-half inch deflection is observed.

(8) Adjust R40 for maximum deflection and R33 to keep the pattern centered.

(9) Readjust the gain control for five lines of deflection.

(10) Adjust R30 for minimum distortion. This is accomplished by adjusting the vertical positioning control R3 first to the top of the screen and then to the bottom of the screen. The deflection should be five lines at any point on the screen.

Should it be necessary to readjust R60 and R61, the two controls which control the television fixed frequencies, the following procedure should be used:

(1) Rotate the sweep selector to H; horizontal fixed frequency.

(2) Connect an audio generator to the vertical input binding post and set the frequency to 7875 cycles per second.

(3) Rotate the locking control to approximately zero.

(4) Be sure the horizontal selector is in the internal position.

(5) Adjust R60 until the pattern stops on the screen.

The same procedure should be followed in adjusting the vertical television fixed frequency.

(1) The frequency of the audio generator should be set to 30 cycles per second.

(2) Adjust R61 until the pattern stops on the screen.

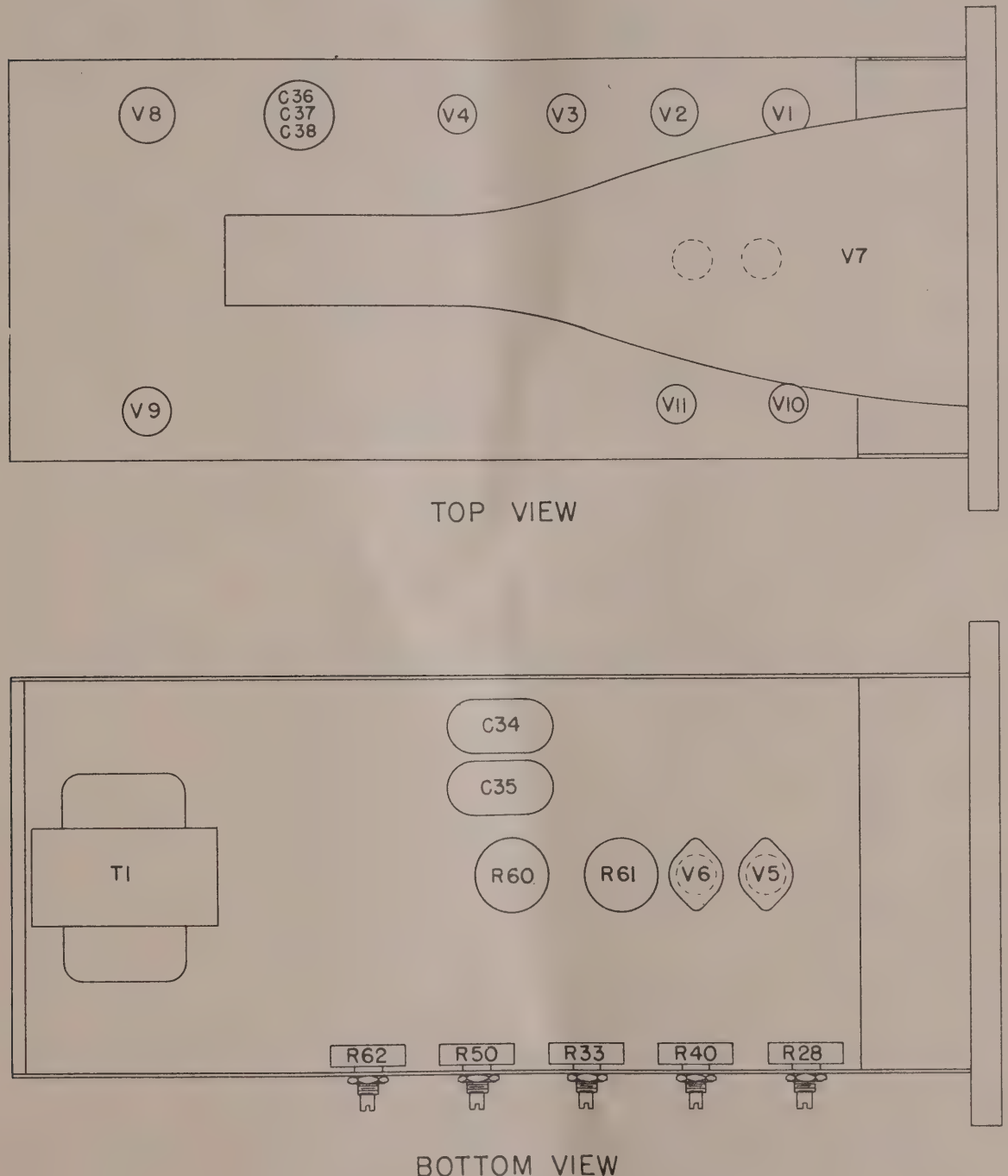

FIGURE 3.1 - CHASSIS VIEW, MODEL 670

PARTS LIST FOR MODEL 670

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

REF. SYMBOL	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
C1	3105-24	CAPACITOR: .1 mfd, 400 V, paper	
C2	3115-7	CAPACITOR: 1-3.5 mmf, trimmer	
C3		CAPACITOR: Same as C1	
C4	3115-1	CAPACITOR: 3-12 mmf, trimmer	
C5	3095-1	CAPACITOR: 5 mmf, 500 V, 20%, mica	
C6		CAPACITOR: Same as C1	
C7	3095-51	CAPACITOR: 390 mmf, 500 V, 10%, mica	
C8	3095-6	CAPACITOR: 220 mmf, 500 V, 10%, mica	
C9		CAPACITOR: Same as C4	
C10		CAPACITOR: Same as C5	
C11	3110-7	CAPACITOR: .005 mfd, ceramic	
C12		CAPACITOR: Same as C11	
C13		CAPACITOR: Same as C1	
C14	3110-22	CAPACITOR: .002 mfd, ceramic	
C15	3105-112	CAPACITOR: .5 mfd, 200 V, 10%, paper	
C16	3095-45	CAPACITOR: 27 mmf, 500 V, 10%, mica	
C17		CAPACITOR: Same as C1	
C18		CAPACITOR: Same as C8	
C19	3105-125	CAPACITOR: .008 mfd, 1600 V, paper	
C20	3095-5	CAPACITOR: 100 mmf, 500 V, 10%, mica	
C21		CAPACITOR: Same as C1	
C22	3105-18	CAPACITOR: 1 mfd, 200 V, paper	
C23	3110-1	CAPACITOR: 50 mmf (½ mmf) special, zero temp. coef., ceramic	
C24	3105-7	CAPACITOR: .025 mfd, 400 V, paper	
C25		CAPACITOR: Same as C1	
C26		CAPACITOR: Same as C15	
C27	3105-113	CAPACITOR: .15 mfd, 200 V, paper	
C28		CAPACITOR: Same as C19	
C29	3105-115	CAPACITOR: .03 mfd, 400 V, 10%, paper	
C30		CAPACITOR: Same as C11	
C31	3095-9	CAPACITOR: .001 mfd, 500 V, 10%, mica	
C32	3095-16	CAPACITOR: 150 mmf, 500 V, 10%, mica	
C33	3105-10	CAPACITOR: .1 mfd, 600 V, paper	
C34	3105-142	CAPACITOR: .5 mfd, 2000 V, Plasticon	
C35		CAPACITOR: Same as C35	
C36	3085-38	CAPACITOR: 20-20-20-20 mfd, 450 V, electrolytic (C37 and C38 in same can)	
C37		CAPACITOR: Same as C36	
C38		CAPACITOR: Same as C36	
C39		CAPACITOR: Same as C20	
C40		CAPACITOR: Same as C33	
C41		CAPACITOR: Same as C24	
R1	18412-751	RESISTOR: 7500 ohms, ½ W, 5%	
R2	18434-101	RESISTOR: 100,000 ohms, 2 W, 5%	
R3	16925-11	POTENTIOMETER: 3000 ohms, carbon	VERT. POS.
R4	18415-221	RESISTOR: 2.2 megohms, ½ W, 5%	
R5	18434-152	RESISTOR: 150,000 ohms, 2 W, 10%	
R6	18433-752	RESISTOR: 75,000 ohms, 2 W, 10%	
R7		RESISTOR: Same as R6	

PARTS LIST FOR MODEL 670

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

REF. SYMBOL	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
R8		RESISTOR: Same as R1	
R9		RESISTOR: Same as R1	
R10	18575-89	RESISTOR: 8500 ohms, 10 W, 10%, wire wound	
R11		RESISTOR: Same as R10	
R12	18414-221	RESISTOR: 220,000 ohms, ½ W, 5%	
R13	18415-222	RESISTOR: 2.2 megohms, ½ W, 10%	
R14		RESISTOR: Same as R4	
R15	18410-472	RESISTOR: 47 ohms, ½ W, 10%	
R16		RESISTOR: Same as R15	
R17		RESISTOR: Same as R15	
R18	18413-221	RESISTOR: 22,000 ohms, ½ W, 5%	
R19	18414-102	RESISTOR: 100,000 ohms, ½ W, 10%	
R20	18415-332	RESISTOR: 3.3 megohms, ½ W, 10%	
R21	18412-472	RESISTOR: 4700 ohms, ½ W, 10%	
R22	18412-271	RESISTOR: 2700 ohms, ½ W, 5%	
R23	18412-102	RESISTOR: 1000 ohms, ½ W, 10%	
R24	18433-241	RESISTOR: 24,000 ohms, 2 W, 5%	
R25		RESISTOR: Same as R15	
R26	18432-512	RESISTOR: 5100 ohms, 2 W, 10%	
R27		RESISTOR: Same as R20	
R28	16925-138	POTENTIOMETER: 5000 ohms, linear, carbon, screw driver slot	BALANCE
R29	16925-27	POTENTIOMETER: 10,000 ohms, linear, carbon	VERT. GAIN
R30	16925-12	POTENTIOMETER: 3000 ohms, linear, 1 watt, wire wound, screw driver slot	CALIBRATION
R31		RESISTOR: Same as R19	
R32	18413-222	RESISTOR: 22,000 ohms, ½ W, 10%	
R33	16925-13	POTENTIOMETER: 10,000 ohms, linear, carbon, screw driver slot	CALIBRATION
R34		RESISTOR: Same as R32	
R35		RESISTOR: Same as R20	
R36		RESISTOR: Same as R13	
R37	18412-241	RESISTOR: 2400 ohms, ½ W, 5%	
R38		RESISTOR: Same as R23	
R39		RESISTOR: Same as R23	
R40	16925-133	POTENTIOMETER: 3000 ohms, linear, carbon, screw driver slot	CALIBRATION
R41		RESISTOR: Same as R20	
R42		RESISTOR: Same as R4	
R43	18415-102	RESISTOR: 1 megohm, ½ W, 10%	
R44	16925-145	POTENTIOMETER: 1 - 5 megohm dual (See R59)	VERNIER
R45	18415-472	RESISTOR: 4.7 megohms, ½ W, 10%	
R46		RESISTOR: Same as R20	
R47		RESISTOR: Same as R13	
R48	18424-222	RESISTOR: 220,000 ohms, 1 W, 10%	
R49	18424-332	RESISTOR: 330,000 ohms, 1 W, 10%	
R50		RESISTOR: Same as R2	
R51		RESISTOR: Same as R21	
R52	16925-24	POTENTIOMETER: 1 megohm, linear, carbon	HORIZ. GAIN
R53	16925-21	POTENTIOMETER: 250,000 ohms, linear, carbon	LOCKING

PARTS LIST FOR MODEL 670

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

REF. SYMBOL	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
R54		POTENTIOMETER: Same as R52	PHASING
R55		RESISTOR: Same as R19	
R56	18413-332	RESISTOR: 33,000 ohms, ½ W, 10%	
R57		RESISTOR: Same as R23	
R58		RESISTOR: Same as R21	
R59		POTENTIOMETER: 1 megohm, part of R44	VERNIER
R60	16925-56	POTENTIOMETER: 1 megohm, linear, carbon, screw driver slot	CALIBRATION
R61	16925-99	POTENTIOMETER: .5 megohm, linear, carbon, screw driver slot	CALIBRATION
R62	16925-129	POTENTIOMETER: 50,000 ohms, linear, carbon, screw driver slot	AST. CONT.
R63	18413-102	RESISTOR: 10,000 ohms, ½ W, 10%	
R64	18433-822	RESISTOR: 82,000 ohms, 2 W, 10%	
R65		RESISTOR: Same as R12	
R66 (S6)	16925-148	POTENTIOMETER: 500,000 ohms, 1 W, with switch	INTENSITY
R67	18424-152	RESISTOR: 150,000 ohms, 1 W, 10%	
R68	18425-102	RESISTOR: 1 megohm, 1 W, 10%	
R69	18413-472	RESISTOR: 47,000 ohms, ½ W, 10%	
R70	16925-147	POTENTIOMETER: 2 megohms, 1 W	FOCUS
R71		RESISTOR: calibration, approx. 68,000 ohms	
R72	18423-472	RESISTOR: 47,000 ohms, 1 W, 10%	
R73		RESISTOR: Same as R67	
R74	18433-272	RESISTOR: 27,000 ohms, 2 W, 10%	
R75		RESISTOR: Same as R74	
R76	18423-822	RESISTOR: 82,000 ohms, 1 W, 10%	
R77	18425-332	RESISTOR: 3.3 megohms, 1 W, 10%	
R78	18411-472	RESISTOR: 470 ohms, ½ W, 10%	
R80		POTENTIOMETER: Same as R29	HORIZ. POS.
R81	18423-222	RESISTOR: 22,000 ohms, 1 W, 10%	
R82	18432-822	RESISTOR: 8200 ohms, 2 W, 10%	
R83		RESISTOR: Same as R22	
R84	18414-152	RESISTOR: 150,000 ohms, ½ W, 10%	
R85		RESISTOR: calibration, Approx. 1200-1500 ohms	
R86	18575-104	RESISTOR: 1000 ohms, 10 W, 10%, vitreous enamel	
S1	19912-221	SWITCH: rotary, 2 pole, 5 position	VERT. ATTEN.
S2	19911-38	SWITCH: toggle, 2 pole, 2 position	VERT. REVERSING
S3	19912-223	SWITCH: rotary, 4 pole, 5 position	HORIZ. SEL.
S4	19912-222	SWITCH: rotary, 3 section, 8 position	COARSE FREQ.
S5	19911-9	SWITCH: toggle, S.P.S.T.	INT. MOD.
S6		SWITCH: on back of potentiometer R66	
S7		SWITCH: Same as S2	HORIZ. REVERSING
T1	20800-111	TRANSFORMER: power	
V1	20875-69	TUBE: 12AU7	
V2	20875-77	TUBE: 12AT7	
V3	20875-71	TUBE: 6J6	
V4		TUBE: Same as V3	
V5		TUBE: Same as V3	
V6	20875-62	TUBE: 6C4	
V7	20875-67	TUBE: 5UP1	

CORRECTIONS TO MODEL 670 INSTRUCTION BOOK (2490-165)

The following changes in the parts list for the Model 670 will be applicable to schematic wiring diagram #775W, alteration A.

REF. SYMBOL	HICKOK CODE NO.	NAME AND DESCRIPTION OF PART
C2	3115-1	CAPACITOR: 3-12 mmf, trimmer
C4		CAPACITOR: Same as C2
C7	3110-12	CAPACITOR: 1000 mmf, ceramic, CRL #BC25
C9		CAPACITOR: Same as C2
C15	3105-110	CAPACITOR: .5 mfd, 400 V, 20%, paper
C18	3095-55	CAPACITOR: 330 mmf, 500 V, 10%, mica
C35		CAPACITOR: Same as C34
C39		CAPACITOR: (delete this component)
C42		CAPACITOR: Same as C20
C43	3115-2	CAPACITOR: 6.5-35 mmf, trimmer
C44	3095-21	CAPACITOR: 2200 mmf, 500 V, 10%, mica
R6		RESISTOR: Same as R5
R7		RESISTOR: Same as R5
R26	18575-100	RESISTOR: 5000 ohms, 5 W, 10%
R56	18413-241	RESISTOR: 24,000 ohms, 1/2 W, 5%
R73	18433-752	RESISTOR: 75,000 ohms, 2W, 10%
R79		RESISTOR: Same as R5
R83	18411-822	RESISTOR: 820 ohms, 1/2 W, 10%
R84	18413-332	RESISTOR: 33,000 ohms, 1/2 W, 10%
R87		RESISTOR: Same as R5
R88		RESISTOR: Same as R43
V9	20875-86	TUBE: 1V2
V10	20875-99	TUBE: 6AB4

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 Dupont Avenue
Cleveland 8, Ohio

DATA TO BE INSERTED IN MODEL 670
INSTRUCTION BOOK, 2490-165
(under Section 4, Maintenance)

COARSE VERTICAL POSITIONING CONTROL

Due to tube and component changes with age in the high gain DC vertical amplifier, the vertical positioning may change slightly. Therefore, a coarse vertical positioning control is made accessible through a hole in the side of the case (see Figure 4.2 for location).

ADJUSTMENT OF COARSE VERTICAL POSITIONING CONTROL

(1) Turn oscilloscope on and allow a 15 minute warmup period.
(2) Set Vert. Pos. control located on front panel to the center of its mechanical rotation.
(3) With a screw driver, adjust the Coarse Pos. control until the beam is in the center of the screen vertically.

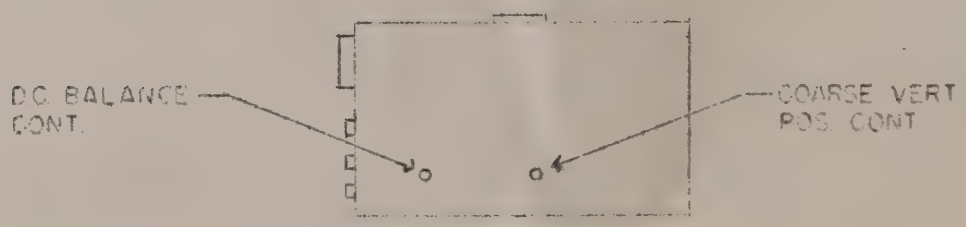

Figure 4.2

DC BALANCE CONTROL

The DC Balance control may need adjustment due to tube and component changes with age. If the DC Balance control is not properly adjusted the beam will shift in a vertical plane as the Vertical Gain control is varied from minimum to maximum. This gives the effect of vertical positioning as the Vertical Gain control is varied.

ADJUSTMENT OF DC BALANCE CONTROL

(1) Turn oscilloscope on and allow a 15 minute warmup period.
(2) Set Vertical Attenuator to X1000.
(3) Set Horizontal Selector to "Amp."
(4) Set Vertical Gain to minimum.
(5) Position the beam to center of screen with Positioning controls.
(6) Set Vertical Gain control to maximum. If the beam moves vertically to a new position, adjust the DC Balance control (see Figure 4.2) until the beam is in the center of the screen.
(7) Vary the Vertical Gain control; beam should not move more than .1 inch. Repeat Step 6 if necessary.

PARTS LIST FOR MODEL 670

NOTE: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

REF. SYMBOL	HICKOK CODE NO.	NAME AND DESCRIPTION	FUNCTION
V8	20875-88	TUBE: 6AX5GT	
V9	20876-86	TUBE: 1V2	
V10		TUBE: Same as V6	
V11		TUBE: Same as V3	
	2490-119	BULLETIN, TECHNICAL: No. 342	
	2490-165	BOOKLET: Instruction	
	3030-58	CABLE ASS'Y: Output	
	3870-2	CRYSTAL: Sylvania Type 1N34 diode	
	6900-5	FUSE: 1 amp, Little fuse 3AG Slo-Blo	
	12270-12	LAMP: #47 G.E., 6-8 volt, .15 ampere	
	12450-225	LEAD ASS'Y: black	

NOTE: When ordering parts or materials for this instrument, the serial number must be given in order to identify properly the material required.

DATA TO BE INSERTED IN MODEL 670
INSTRUCTION BOOK, 2490-165
(under Section 4, Maintenance)

COARSE VERTICAL POSITIONING CONTROL

Due to tube and component changes with age in the high gain DC vertical amplifier, the vertical positioning may change slightly. Therefore, a coarse vertical positioning control is made accessible through a hole in the side of the case (see Figure 4.2 for location).

ADJUSTMENT OF COARSE VERTICAL POSITIONING CONTROL

(1) Turn oscilloscope on and allow a 15 minute warmup period.
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(3) With a screw driver, adjust the Coarse Pos. control until the beam is in the center of the screen vertically.

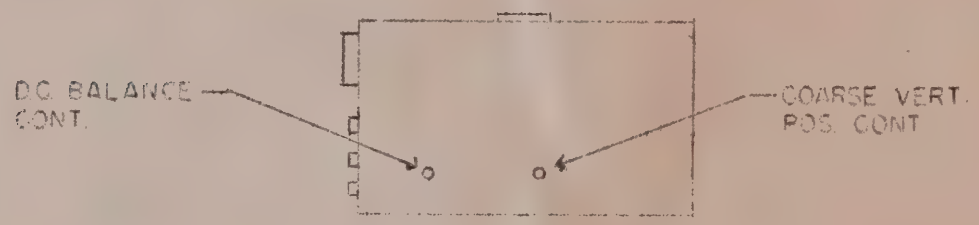


Figure 4.2

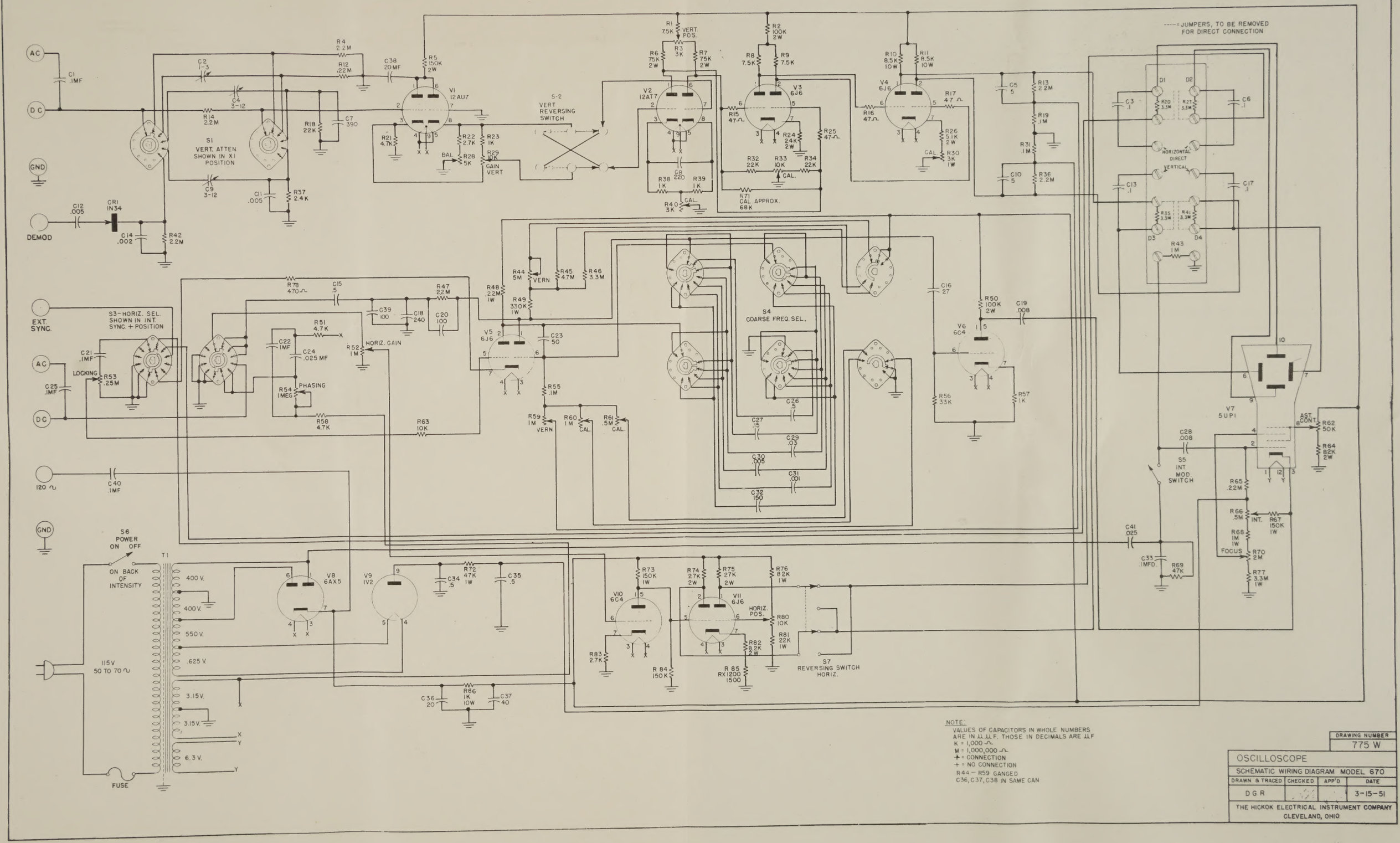
DC BALANCE CONTROL

The DC Balance control may need adjustment due to tube and component changes with age. If the DC Balance control is not properly adjusted the beam will shift in a vertical plane as the Vertical Gain control is varied from minimum to maximum. This gives the effect of vertical positioning as the Vertical Gain control is varied.

ADJUSTMENT OF DC BALANCE CONTROL

(1) Turn oscilloscope on and allow a 15 minute warmup period.
(2) Set Vertical Attenuator to X1000.
(3) Set Horizontal Selector to "Amp."
(4) Set Vertical Gain to minimum.
(5) Position the beam to center of screen with Positioning controls.
(6) Set Vertical Gain control to maximum. If the beam moves vertically to a new position, adjust the DC Balance control (see Figure 4.2) until the beam is in the center of the screen.
(7) Vary the Vertical Gain control; beam should not move more than .1 inch. Repeat Step 6 if necessary.

ALT	DRAWING NUMBER
	775 W



NOTE:
VALUES OF CAPACITORS IN WHOLE NUMBERS ARE IN μμF. THOSE IN DECIMALS ARE μF
K = 1,000 Ω
M = 1,000,000 Ω
+ = CONNECTION
+ = NO CONNECTION
R44 – R59 GANGED
C36, C37, C38 IN SAME CAN

DRAWING NUMBER	
775 W	

OSCILLOSCOPE
SCHEMATIC WIRING DIAGRAM MODEL 670

DRAWN & TRACED	CHECKED	APP'D	DATE
D G R			3-15-51

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CLEVELAND, OHIO

FIGURE 4.1 - SCHEMATIC MODEL 670

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